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ORIGINAL PAPER

Standardized pod collection time, pod length and pre-sowing treatment of *Albizia lebbeck* at terai zone of West Bengal, India

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Abstract: Three pod lengths (< 10 cm, 10–20 cm and > 20 cm) and 13 pre-sowing treatments were considered with four dates of collection (9 February, 19 February, 1 March and 11 March) to investigate their effect on germination rate and growth of seedlings of *Albizia lebbeck* (L.) Benth. at Pundibari, West Bengal, India. The best time of pod collection was on 19 February as the germination rate of the seeds collected on this date was 92.5% without requiring any pre-sowing treatments. This clearly indicated that the seeds collected on 19 February were non-dormant, viable and physiologically mature. Significantly better seedling growth was also obtained when the seeds were sown on 19 February which was extracted from pods of length 10-20 cm. Application of thiourea as a pre-treatment did not significantly enhanced seed germination rate, but its application in lower concentration (100 $\mu L \cdot L^{-1}$) resulted in better seedling growth and development.

Keywords: *Albizia lebbeck*; collection date; pod length; pre-sowing treatment; germination; growth

Introduction

Albizia lebbeck (L.) Benth. is one of the important tree species in arid and semi-arid regions of India (Anon 1983). It is a leguminous and multipurpose species adapted to a wide variety of environmental conditions because of its hardy nature. It nodulates readily and its leaves are highly palatable and proteinaceous (Prinsen 1986). *A. lebbeck* is a desirable species for energy plantations because of its nitrogen fixing properties and green manuring capabilities (Palani et al. 1996; Mutha et al. 2004). Due to its multipurpose uses, *A. lebbeck* is a suitable tree species for farm forestry plantations to be grown on field boundaries and hedges. The quality demand for seed in raising commercial plantations is increasing these days. Unfortunately in India, particularly in terai region of West Bengal, there is no seed orchard of this species. The seeds are collected from natural stands (Shukla et al. 2007). At maturity stages, the pods harvested from the trees were found significantly to influence germination of seeds in many species. It is therefore, necessary to determine the optimum stage at which the pods should be harvested from the trees (Bhardwaj 2001). Thus calendar date and pod length have been the important parameters for determination of the optimum seed source and maturity indices for better nursery performance.

An initial care is essential from the germination stage for *A. lebbeck* because of its seed dormancy (Palani et al. 1996; Mutha et al. 2004). Therefore, to facilitate germination in this species, its seed must be placed in favourable environmental conditions with adequate moisture supply, appropriate gaseous balance and optimum light through chemical and mechanical scarification. Treating with potassium nitrate or thiourea can also break the dormancy of its seed (Heydecker and Coolbear 1977). As *A. lebbeck* represents leguminosae family, its seeds are exogenously dormant primarily due to its impermeable seed coat or pericarp. Therefore, the characteristics of *A. lebbeck* impede proper and complete germination of the seeds. Roy (1992) has successfully attempted mechanical and chemical scarification for seed coat of *A. lebbeck* through sulphuric acid, potassium nitrate and thiourea. The present study was undertaken to standardize the date of pod collection, pod length and pre-sowing treatments for proper and optimum seed germination and seedling growth of *A. lebbeck* in terai zone of West Bengal.

Methods and materials

Study area

This study was carried out in Central Forest Nursery, Department of Forestry Uttar Banga Krishi Viswavidyalaya Pundibari at Cooch Behar district of West Bengal state in India from February to July, 2007. The experimental site was located at an elevation of 43 m a.s.l., with sub-tropical climate receiving average annual rainfall of 250–300 cm from south-west monsoon. About 80% of

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this rainfall was received from June to August. The weather during the study period was normal. The soil of the nursery was from sandy to sandy loam with acidic reaction, low in organic carbon, medium in available nitrogen and phosphorus and high in available potash.

Fruit and seeds

About 50 trees of *A. lebbeck* were marked outside the university campus for seed collection. The selected trees were at similar age between 10 and 12 years. The trees initiated to flower on 27 of July and the full bloom was recorded on 2 August. Pod formation began about one month after flowering. The pods from these trees were plucked in the four dates, i.e. on 9 February, 19 February, 1 March and 11 March, 2007. The pods were graded as three classes according to their length (less than 10, 10–20 cm and more than 20 cm) before the seeds were extracted from them.

Pre-sowing treatments

The seeds were given the following pre-sowing treatments: soaked in cold water for 24 h (T_1); soaked in warm water for 24 h (T_2); dipped in boiling water for 3 min, with subsequent cooling for 24 h (T_3); dipped in boiling water for 6 min with subsequent cooling for 24 h (T_4); dipped in concentrated H_2SO_4 for 5 min, followed by washing and then soaking in cold water for 12 h (T_5); dipped in concentrated H_2SO_4 for 8 min, followed by washing and then soaking in cold water for 12 h (T_6); soaked in 100 $\mu L \cdot L^{-1}$ thiourea for 12 h (T_7); soaked in 200-$\mu L \cdot L^{-1}$ thiourea for 12 h (T_8); soaked in 300-$\mu L \cdot L^{-1}$ thiourea for 12 h (T_9); soaked in 100-$\mu L \cdot L^{-1}$ thiourea for 24 h (T_{10}); soaked in 200-$\mu L \cdot L^{-1}$ thiourea for 24 h (T_{11}); soaked in 300-$\mu L \cdot L^{-1}$ thiourea for 24 h (T_{12}); and no pre-sowing treatment or control (T_{13}).

Hundred uniform seeds were sown immediately for each treatment combinations after extraction of seeds from the graded pods of every subsequent collection. Germination rate was recorded daily in the nursery beds till to 21 days. The data obtained after seed germination were used to calculate the seed germination rate, germination capacity (GC), germination energy (GE), germination value (GV), germination speed (GS) and seedling vigour index (SVI). All these parameters were calculated following the procedures of ISTA (Anon 1976). Seeds with 5 mm long radicals were considered as germinated (Bhardwaj 2001). Growth parameters like shoot and root length, shoot and root diameter, shoot and root dry weight and root/ shoot ratio were also recorded. The experiment was laid out in factorial randomized block design replicated thrice. The data were analyzed by variance with the help of a personal computer (Gomez and Gomez 1984).

Results

Effect on germination

Date of collection

The germination of *A. lebbeck* was significantly influenced by the dates of collection of pods (Table 1). The pods collected on 19 February (second collection) had the highest germination rate (88.61%), followed by 61.67% on 1 March (third collection) and least (34.72%) on 9 February (first collection). Similarly other germination parameters were also significantly influenced by the date of pod collection (Table 2).

Table 1. Effect of pod length and date of collection on germination of *Albizia lebbeck*

Date of collection	Germination rate (%)			
	Pod length (cm)			
	<10	10-20	>20	Mean
9 February	21.67 (27.68)*	42.50 (40.67)	40.00 (39-21)	34.72
19 February	84.17 (66.65)	92.50 (74.25)	89.17 (70-90)	88.61
1 March	55.00 (47.88)	65.83 (54.23)	64.17 (52.34)	61.67
11 March	33.33 (35.26)	40.00 (39.23)	38.33 (38.25)	37.22
Mean	48.54	60.21	57.92	

Notes: CD (p = 0.05); Date of collection = 3.24; Pod length = 2.80.

Table 2. Effect of pod length and date of collection on germination parameters of *Albizia lebbeck*

Date of collection	GC	GE	GV	GS	SVI
9 February	53.33 (46.94)*	16.78 (23.80)	3.09	3.97	519.97
19 February	91.39 (73.34)	60.28 (51.29)	19.98	22.65	1406.16
1 March	70.56 (57.17)	42.50 (40.63)	8.97	8.87	1166.23
11 March	51.39 (45.79)	26.39 (30.73)	3.99	5.82	712.25
C D (p = 0.05)	3.29	10.86	1.07	1.16	92.85
Pod length (cm)	GC	GE	GV	GS	SVI
< 10	61.46 (52.39)	31.96 (33.65)	7.42	9.55	851.10
10-20	71.04 (58.77)	42.50 (40.28)	9.96	11.01	1055.09
> 20	67.50 (56.27)	35.00 (35.91)	9.68	10.42	947.28
C D (p = 0.05)	2.85	9.40	0.93	1.00	80.41

Notes: GC is the Germination capacity, GE the Germination energy, GV the Germination value, GS the Germination speed, and SVI is Seedling vigour index. *Figures in parenthesis are ARC SIN values.

Pod length

Pod length had a significant effect on the germination of *A. lebbeck* (Table 1). The highest germination rate (60.21%) was recorded when seeds extracted from pods of 10–20 cm long, followed by the pods of > 20 cm in length (57.92%) while lowest germination rate (48.54%) was recorded with pods of <10 cm in length. Many reports supported that longer pods had bolder seeds that gave better germination rates, such as *Albizia chinensis* (Kumar et al. 2001; Bhardwaj et al. 2002b), *Albizia procera* (Shukla et al. 2007), *A. lebbeck* (Roy 1985; Bhardwaj et al.

2002a; Mutha et al. 2004), *Dalbergia sissoo* (Kanak S. and Sahai K. 1994), and *Acacia nilotica* (Bal Krishna and Singh 1995). Similarly, pod length also had significant effect on the various germination parameters viz. germination capacity, germination value, germination speed and germination vigour except germination energy of *A. lebbeck* (Table 2).

Pre-sowing treatments

The seeds of *A. lebbeck* generally require some kinds of pre-sowing treatments (Agboola et al. 2005). The highest seed germination rate (55%) was obtained by soaking the seeds in 200 $\mu L \cdot L^{-1}$ of thiourea for 12 h (T_8), followed by thiourea of 100 $\mu L \cdot L^{-1}$ (T_7) and 300 $\mu L \cdot L^{-1}$ (T_9) for 12 h and cold (T_1) and hot water (T_2) for 24 h (Table 3). Control (no treatments) has significantly low germination rate, compared to T_8, T_7, T_9, T_1 and T_2. Seed germination rate was drastically reduced when the seeds were dipped in concentrated acid for 5 min (T_5) and 8 min (T_6) and also boiling water dip for 3 min (T_3) and 6 min (T_4). The treatment T_6 was most damaging, which resulted into the lowest seed germination rate in all treatments (10.21 %). This might be due to longer exposure of the seeds to these treatments, which had partially or completely damaged embryo of seeds.

Interaction effect

Date of collection and pod length

Table 1 clearly indicated that the best seed germination rate (92.50%) was obtained when the best date of collection (19 February) was combined with the best length of pod (from 10 cm to 20 cm). Similar interaction effect was also observed for all the germination parameters.

Date of collection and pre-sowing treatment

Significant interaction effects of sowing dates and pre-sowing treatments were also recorded in Table 3. The effects of pre-sowing seed treatments (T_4, T_5 and T_6) were the worst, which completely damaged the seeds with complete failure of germination. The seeds collected on 19 February had the best germination rate when exposed to the best pre-sowing treatments i.e. T_7, T_8 and T_9.

Table 3. Effect of date of collection and pre-sowing treatments on germination of *Albizia lebbeck*

Date of collection	Pre-sowing treatments													
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	T_{13}	Mean
9 February	42.50	37.50	4.18	0.00	0.00	0.00	47.50	49.17	38.50	13.33	17.50	16.67	68.33	25.78
	(40.66)*	(37.70)	(11.64)	(4.05)	(4.05)	(4.05)	(43.52)	(44.52)	(38.32)	(21.29)	(24.44)	(23.94)	(55.83)	(27.23)
19 February	60.00	68.33	43.33	15.83	46.50	20.83	87.50	82.50	75.00	56.67	65.83	74.17	33.33	56.14
	(51.04)	(55.89)	(41.13)	(23.39)	41.44)	27.19)	(69.56)	(65.39)	(60.20)	(48.85)	(54.25)	(59.93)	(35.26)	(48.73)
1 March	54.17	46.83	38.33	18.33	48.33	23.33	54.17	51.67	52.67	38.33	46.67	38.33	23.83	41.31
	(47.56)	(43.18)	(38.19)	(25.34)	(43.56)	(28.88)	(47.39)	(45.96)	(46.53)	(38.24)	(43.08)	(38.22)	(30.54)	(39.74)
11 March	40.83	44.17	20.00	6.67	19.17	20.83	25.83	36.67	32.50	26.67	38.33	31.67	22.50	28.14
	(39.69)	(41.61)	(26.45)	(14.78)	(25.84)	(27.03)	(30.47)	(37.26)	(34.51)	(31.07)	(38.24)	(34.23)	(28.29)	(31.49)
Mean	49.37	49.21	26.46	10.21	28.50	16.25	53.75	55.00	49.67	33.75	42.08	40.21	37.50	
	(44.71)	(44.60)	(29.36)	(16.89)	(28.72)	(21.78)	(47.74)	(48.29)	(44.89)	(34.86)	(40.00)	(39.08)	(37.8)	

Notes: * Figures in parenthesis are ARC SIN values; C D ($p = 0.05$); Date of collection = 3.68; Pre-sowing treatments = 6.64.

Effect on seedling growth

Date of collection

Seedling growth parameters of *A. lebbeck* were significantly affected by the date of pod collection (Table 4). Root length, root diameter, root dry weight, shoot length, shoot diameter, shoot dry weight and ratio of root to shoot were recorded to be the highest on 19 February, whereas, on 11 March these parameters were recorded to be the lowest values.

Pod length

The length of pods also significantly influenced the seedling growth (Table 4). All the growth parameters were significantly better when the seeds were extracted from the medium length pods (10–20 cm) than the other two categories of pod length (> 10 and < 20 cm).

Pre- sowing treatments

Pre-sowing treatments had significant effect on initial seedling growth of *A. lebbeck* over the control (Table 5). Overall exposure of thiourea to the seeds proved to be the best pre-sowing treatment for the seedling growth as all the growth parameters are significantly better than those of other pre-sowing treatments.

Discussion

Significant influence of collection dates on seed germination rates was also reported by Bhardwaj et al. (2002 a & b) for *A. lebbeck*. This clearly indicated that the pods collected on 19 February were physiologically mature and viable enough to enable seed germination but germination rates were decreased significantly for the seeds collected after 19 February. This can be attributed to viability loss of these seeds (Table 6). Further, moisture content of these seeds also was decreased gradually from 25.43% to 19.56% (Table 6). This decrease in moisture content might have reduced the viability of the seeds. Similar observation was also reported in *A. lebbeck* by Bhardwaj et al. (2002a).

Although the seeds of *A. lebbeck* are orthodox in nature but seed germination rate decreased as its moisture content reduced. Walters and Towill (2004) reported variation in the ability of orthodox seeds to withstand drying and storage. Some seeds are intermediate in their storage capability while others are fully orthodox. This explains that in spite of *A. lebbeck* seeds being orthodox, its germination rate was decreased as moisture content reduced.

Table 4. Effect of pod length and date of collection on seedling growth of *Albizia lebbeck*

Date of collection	Root length (cm)	Root dia. (mm)	Root dry weight (g)	Shoot length (cm)	Shoot dia. (mm)	Shoot dry weight (g)	Root/shoot ratio
9 February	19.10	7.78	3.14	58.66	5.98	11.85	0.26
19 February	24.93	8.63	3.79	74.86	6.90	13.88	0.31
1 March	22.78	7.96	3.75	67.98	6.11	12.06	0.31
11th March	17.23	7.27	2.59	55.81	5.36	10.96	0.21
C D (p = 0 .05)	0.40	0.19	0.20	1.06	0.097	1.03	0.055
Pod length (cm)	Root length (cm)	Root dia. (mm)	Root dry weight (g)	Shoot length (cm)	Shoot dia. (mm)	Shoot dry weight (g)	Root/shoot ratio
< 10	20.01	7.19	2.54	63.01	5.31	9.46	0.24
10–20	21.82	8.40	4.09	66.36	6.53	13.99	0.30
> 20	21.20	8.16	3.33	63.62	6.42	13.11	0.29
C D (p = 0.05)	0.34	0.16	0.17	0.92	0.084	0.89	0.048

Table 5. Effect of date of collection and pre-sowing treatments on seedling growth of *Albizia lebbeck*

Date of collection	Root length (cm)	Root dia. (mm)	Root dry weight (g)	Shoot length (cm)	Shoot dia. (mm)	Shoot dry weight (g)	Root/shoot ratio
9 February	18.08	5.65	2.43	49.16	4.15	9.87	0.18
19 February	26.56	8.10	4.05	76.21	6.19	14.86	0.27
1 March	26.43	8.04	3.85	75.82	6.10	14.72	0.26
11 March	24.83	7.38	3.71	72.59	5.57	13.93	0.24
C D (p = 0.05)	0.36	0.011	0.52	0.18	0.013	0.52	0.002
Pre sowing treatments	Root length (cm)	Root dia. (mm)	Root dry weight (g)	Shoot length (cm)	Shoot dia. (mm)	Shoot dry weight (g)	Root/shoot ratio
T1	25.40	8.33	4.12	72.31	6.33	15.50	0.26
T2	25.01	7.58	3.65	71.28	5.64	13.30	0.27
T3	23.12	6.10	3.48	66.20	4.43	12.46	0.27
T4	18.14	4.82	3.09	54.21	3.51	10.37	0.22
T5	19.43	5.80	3.03	56.46	4.39	10.58	0.21
T6	19.24	5.80	2.84	56.09	4.56	9.51	0.22
T7	27.21	8.50	3.89	76.57	6.36	15.57	0.25
T8	26.92	8.78	3.79	75.56	6.59	14.84	0.26
T9	26.64	8.33	3.54	75.10	6.35	14.78	0.25
T10	26.14	8.17	3.34	74.41	6.34	14.39	0.24
T11	25.97	8.19	3.33	73.76	6.23	13.93	0.24
T12	26.44	8.06	3.08	73.61	6.15	14.42	0.22
T13	21.92	6.32	3.93	64.25	4.65	13.84	0.18
C D (p = 0.05)	0.65	0.020	0.94	0.40	0.023	0.93	0.003

The pods of 10–20 cm length also gave higher seed germination rate and better seedling growth of *A. lebbeck.* This is in agreement with the report on *A. lebbeck* by Bal Krishna and Singh (1995), indicating that bolder seeds extracted from longer pods also gave better germination rate and enhanced growth of the seedlings. Longer pods contain bolder seeds with large cotyledons. These seeds can store more foods or nutrients for the developing embryo (Mutha et al. 2004). Pre-sowing treatments deteriorated seed germination in all the treatment combinations. Even some pre-sowing treatments completely damaged the seeds, resulting failure of seed germination. This clearly brings out that *A. lebbeck* seeds in terai zone of West Bengal do not require any

kind of pre-sowing treatments.

Table 6. Effect of pod length and date of collection on moisture content and viability of *Albizia lebbeck* seeds

Date of collection	Moisture content (%)	Viability (%)
9 February	30.13 (25.26)*	35.66 (36.45)
19 February	25.43 (18.44)	91.11 (73.31)
1 March	21.45 (13.39)	63.11 (52.65)
11 March	19.56 (11.22)	38.44 (38.30)
C D (p = 0.05)	0.27	3.35
Pod length (cm)	Moisture content (%)	Viability (%)
0–10	25.43 (18.86)	50.25 (45.58)
10–20	22.90 (15.41)	62.75 (54.34)
Above 20	24.09 (16.97)	58.25 (50.62)
C D (p = 0.05)	0.23	2.90

Notes: *Figures in parenthesis are ARC SIN values.

The seeds sown on 19 February resulted in better seedling growth. All the growth parameters were significantly better when the seeds were extracted from the 10–20 cm long pods. Similar result was also reported on all parameters of seedling growth by Shukla et al. (2007) in *A. procera*. The seeds collected from 19 February also had the best germination rate. This resulted into better establishment of seedling and hence having the best growth of seedling. Although, thiourea did not influenced seed germination but enhanced seedling growth because it is a growth hormone that increases the biomass (Malik 2002).

Conclusions

It was concluded from the present study that the best date of pod collection for *A. lebbeck* in terai zone of west Bengal is on 19th February but the collected pods should be more than 10 cm in length and must be sown immediately after the collection to get better seed germination rate. However, thiourea can be sprayed as growth hormone in low concentration of 100 $\mu L \cdot L^{-1}$ for induction of better growth of the seedlings in the nursery.

References

Agboola DA, Ebofin AO, Aduradola AM, Ajiboye AA. 2005. The effect of pre-sowing treatment on the germination of seeds of two savannah tree legumes. *Indian Forester*, **131**: 701–10.

Anon. 1976. International rules for seed testing: Rules. 1976. *Seed Science* and *Technology*, **4**: 3–49.

Anon. 1983. *Troup's Silviculture of Indian Trees*. Vol. IV. *Leguminosae*. Dehra Dun: Forest Research Institute and Colleges, p. 345.

Bal Krishna, Singh V. 1995. Effects of seed size and colour on germination and seedling growth in trees species. *Advance Horticulture and Forestry*, **4**: 199–204.

Bhardwaj SD, Panwar P, Kumar M. 2002a. Physical and biochemical change in seeds as maturity indices for harvesting *A. lebbeck* seeds. *Journal of Hill Research*, **15**: 52–55.

Bhardwaj SD, Sharma S, Panwar P. 2002b. Standardization of date of collection and mother tree diameter class for harvesting *A. Chinensis* seeds. *Range Management and Agroforestry*, **21:** 225–227.

Bhardwaj SD. 2001. Co-ordinated project on improvement and silvilcultural techniques for A. chinensis. Final technical report, 1997–2001. pp. 38–39.

Gomez KA and Gomez AA. 1984. *Statistical Procedure for Agriculture Research*. New York: John Willey and Sons, Inc., p. 680.

Heydecker W and Coolbear P. 1977. Seed treatments for improved performance – survey and attempted prognosis. *Seed Science and Technology*, **5**: 353–425.

Kumar M, Bhardwaj SD, Panwar P. 2001. Effect of pod and seed size on germination parameters of *A. lebbeck*. *Indian Journal of Forestry*, **24***:* 496–499.

Malik CP. 2002. *Plant Physiology*. Ludhiana: Kalyani Publishers, p. 747.

Mutha N, Bohra MD, Burman U, Harsh LN. 2004. Effect of seed size and pretreatment on germination of *A. lebbeck* L. Benth. *Indian Journal of Forestry*, **27**:11–14.

Palani M, Dasthagir MG, Kumaran K, Jerlin R. 1996. Effect of pre-sowing treatment on growth attributes of *Albizia lebbeck* (L.) Benth. *Annals of Forestry*, **4:** 85–88.

Prinsen JH. 1986. Potential of *Albizia lebbeck* (Mimosaceae) as tropical fodder tree. A review of literature. *Tropical Grassland*, **119**: 78–83.

Roy MM. 1992. Effect of seed pre-treatment with potassium nitrate and thiourea on germination of *Albizia lebbeck*. *Indian Journal of Forestry*, **15**: 356–57.

Kanak S. and Sahai K. 1994. Studies on seed position and their effect on germination and seedling survival in *D. sissoo* Roxb. *Indian Forester*, **120:** 464–465.

Shukla G, Chakravarty S, Panwar P. 2007. Effect of date of collection and pre-sowing treatments on germination and initial seedling growth of *Albizia procera* in Terai Zone of West Bengal. *Environment and Ecology*, **25**: 617–21.

Walters C and Towill L. 2004. *Seeds and Pollen*. Agricultural Handbook Number 66. The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks. USDA-ARS, National Center for Genetic Resources Preservation Preservation of Plant Germplasm Research, Fort Collins, CO. http://www.ba.ars.usda.gov/hb66/153seeds.pdf.